2-18-2016

Webinar: Development of a Pedestrian Demand Estimation Tool

Kelly Clifton
Portland State University, kclifton@pdx.edu

Development of a Pedestrian Demand Estimation Tool

Framework and Methods

Kelly J Clifton, PhD

Portland State University

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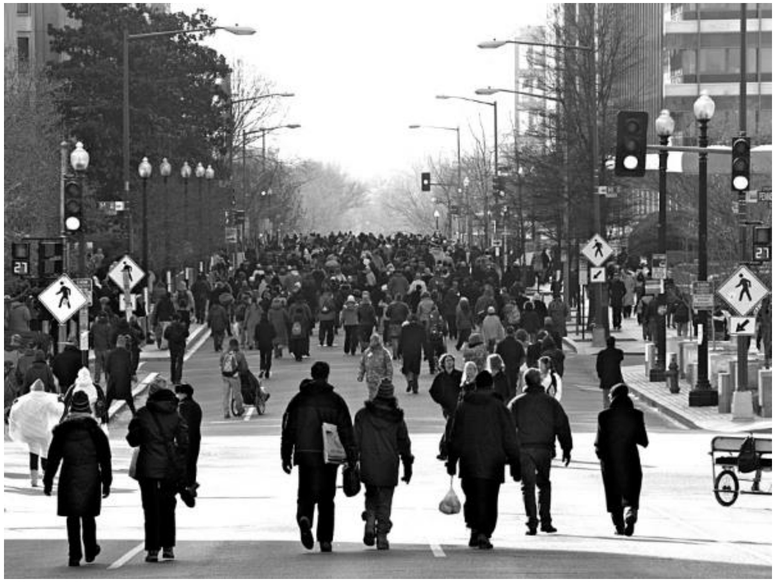
Metro

Outline

- Background
- Project, methods, zones, & data
- Pedestrian index of the environment (PIE)
- I: Trip generation
- II: Walk mode split
- III: Pedestrian destination choice
- Conclusions & future work



Adapted from: http://www.flickr.com/photos/takomabibelot/3223617185

BACKGROUND

Background

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Why model pedestrian travel?

plan for pedestrian investments
& non-motorized facilities

mode shifts

health & safety

greenhouse
gas emissions

new data

Background

How do travel models estimate walking?

- Among 48 large MPOs in US:
  - 38% did not estimate walking
  - 33% estimated non-motorized (walking + bicycling) travel
  - 29% estimated walking
- Lacking pedestrian built environment measures & small spatial units

Trip-based model sequence

1. **Generation**
2. **Distribution**
3. **Mode choice**
4. **Assignment**

Source: Singleton, P. A., & Clifton, K. J. (2013). Pedestrians in regional travel demand forecasting models: State-of-the-practice.

Background

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What are some opportunities?

- ***Walking behavior data***
  - improved travel surveys, pedestrian count data collection
- ***Built environment data***
  - archived spatial datasets, GIS processing
- ***Travel demand models***
  - smaller zones, complete networks, computer power
- ***Walking behavior research***
  - more knowledge and studies

PROJECT, METHODS, ZONES & DATA

Project overview

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- Partnered with Metro: metropolitan planning organization for Portland, OR
- Two research projects
- Improve representation of pedestrian environment in current 4-step method

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Metro

Current 4-step method

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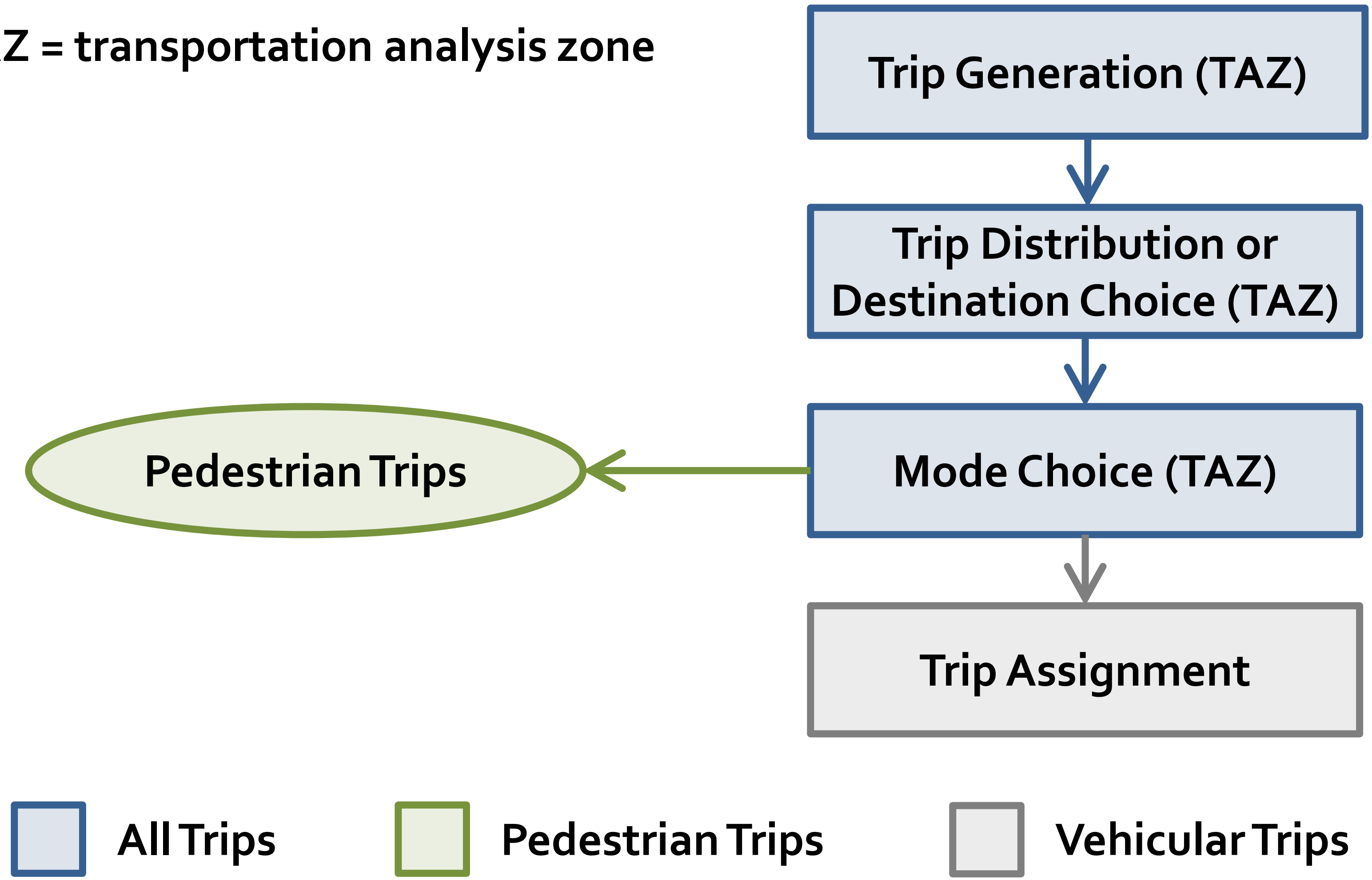
TAZ = transportation analysis zone



New MoPeD method

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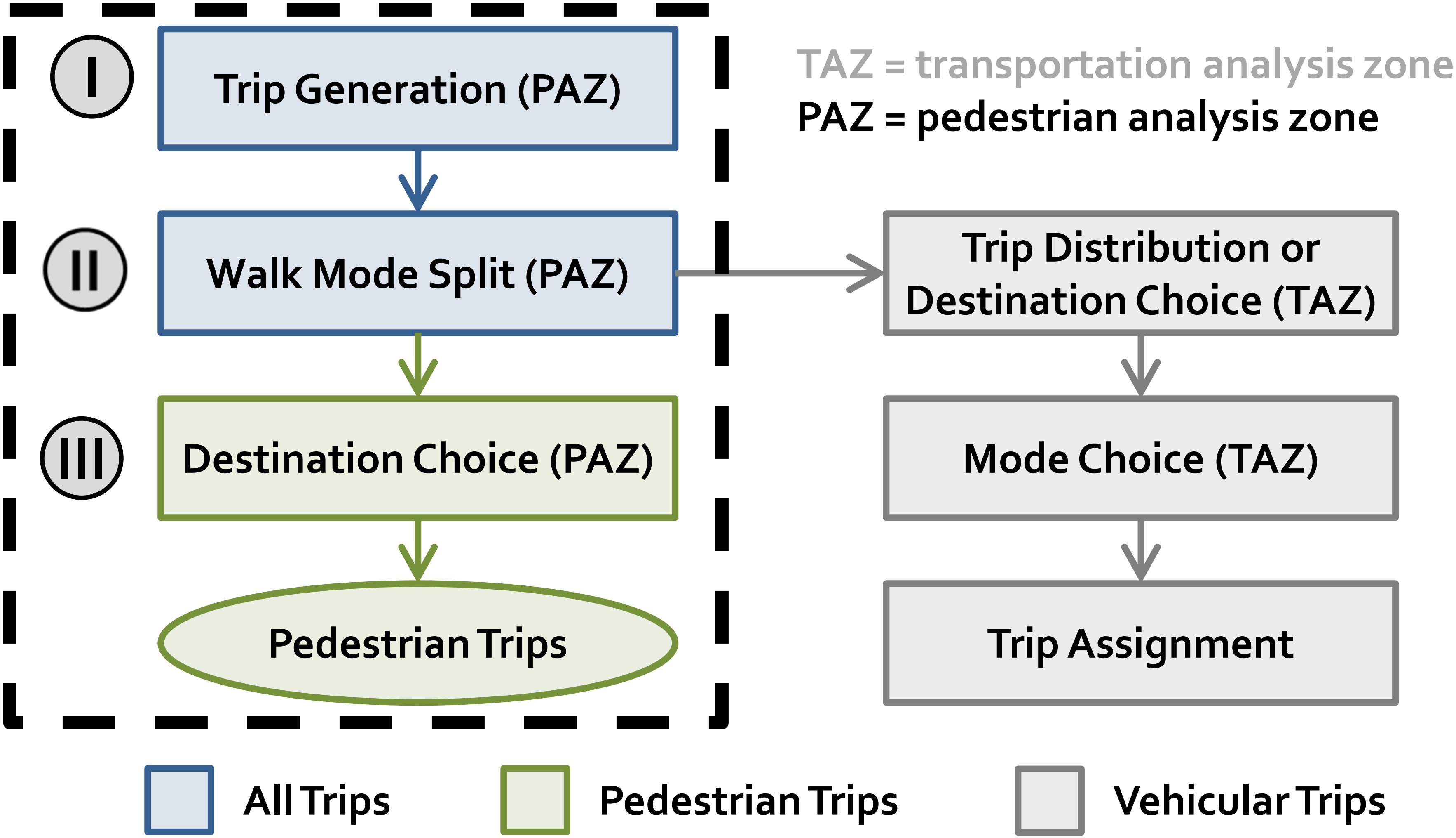


MoPeD Contributions

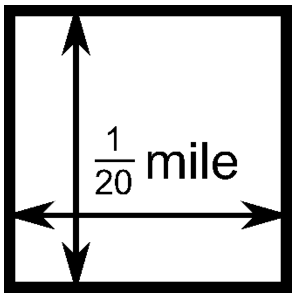
Operates at a smaller spatial scale, more relevant to pedestrians (PAZ)

Utilizes spatially fine-grained archived information on the built environment

Incorporates knowledge of influences on pedestrian travel behavior

Designed to work with regional travel demand model or as standalone tool

Pedestrian analysis zones



264 feet = 80 m ≈ 1 minute walk

Metro: ~2,000 TAZs → ~1.5 million PAZs

TAZs

PAZs

Home-based work trip productions

Travel survey data

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- Oregon Household Activity Survey (OHAS)
  - Household-based survey
  - One-day travel diary
- Portland region dataset (2011)
  - 6,100 households
  - 13,400 people
  - 56,000 trips ÷ <u>4,500 walk trips</u>
    ≈ <u>8% walk mode share</u>

PEDESTRIAN INDEX OF THE ENVIRONMENT (PIE)

Pedestrian environment

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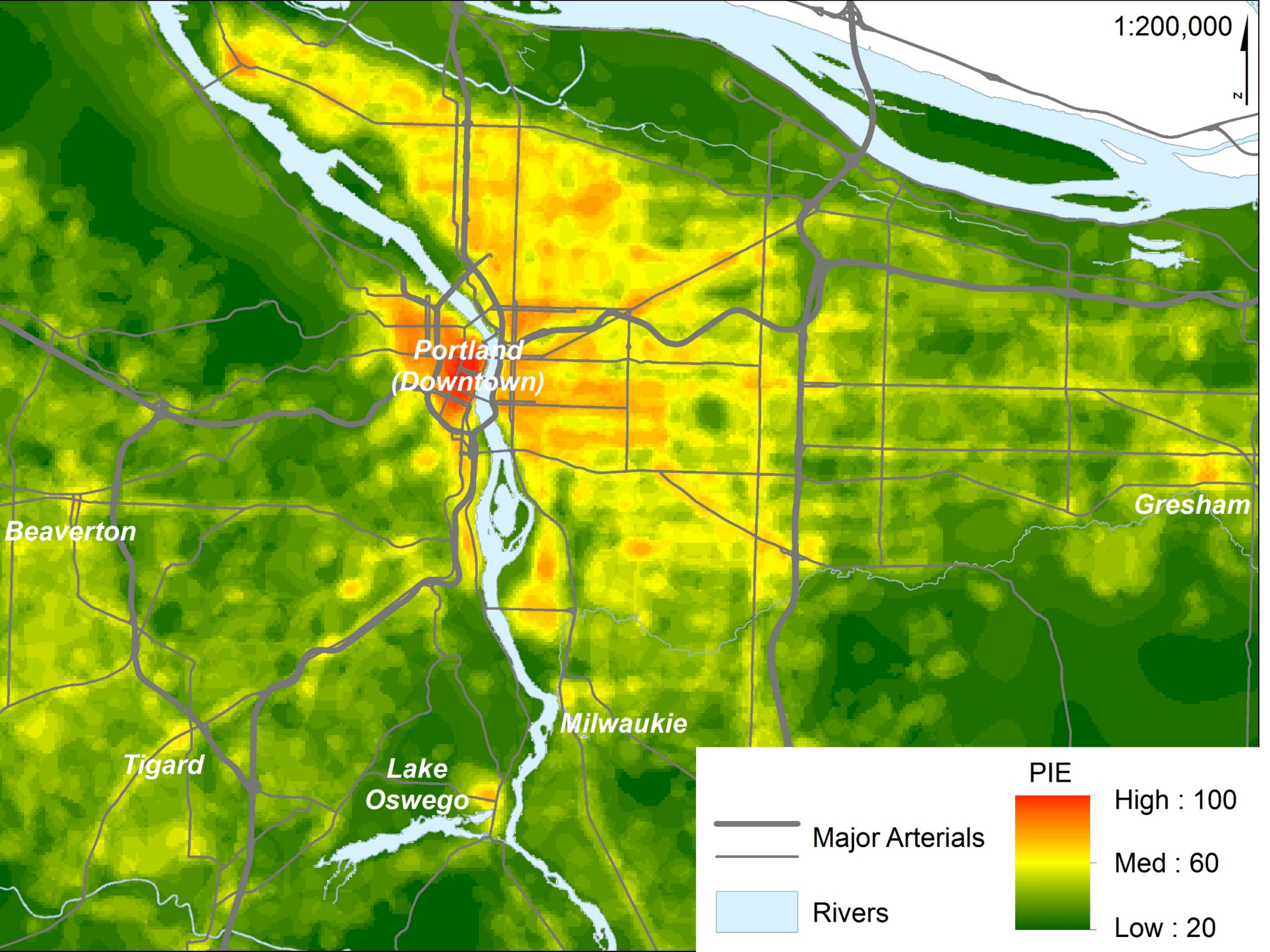
Pedestrian Index of the Environment (PIE)

20–100 score = calibrated ∑(6 dimensions)

- People & job density
- Transit access
- Urban living infrastructure
- Block size
- Sidewalk extent
- Comfortable facilities

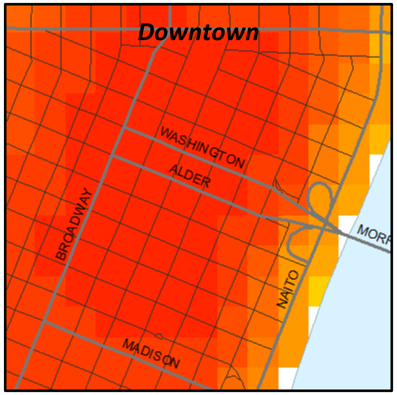
ULI = Urban Living Infrastructure: pedestrian-friendly shopping and service destinations used in daily life.



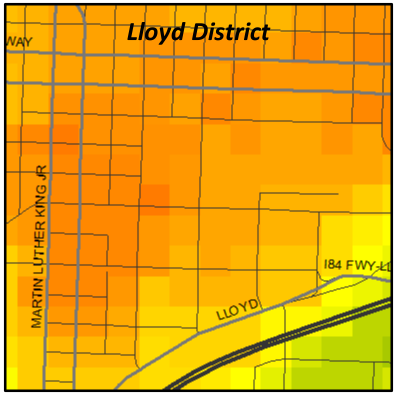
1:200,000
N
Portland (Downtown)
Beaverton
Gresham
Milwaukie
Tigard
Lake Oswego
Major Arterials
Rivers
PIE
High : 100
Med : 60
Low : 20

Visualizing PIE

100 – Downtown core

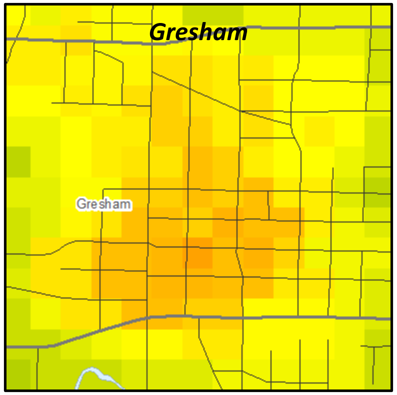


80 – Major neighborhood centers

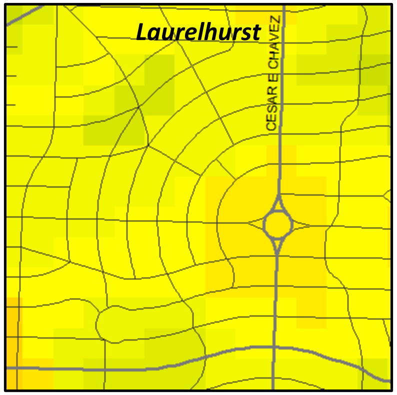


Visualizing PIE

70 – Suburban downtowns



60 – Residential inner-city neighborhoods



Visualizing PIE

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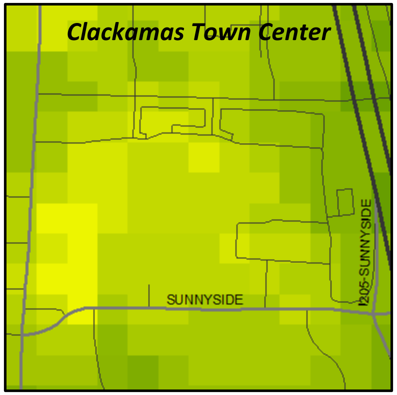
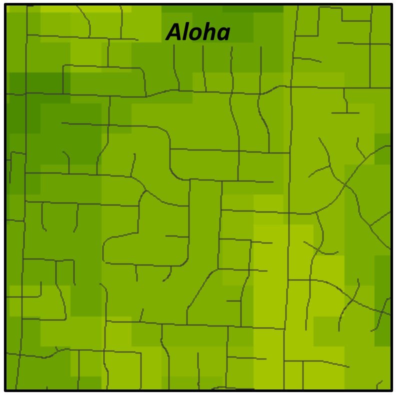
50 – Suburban shopping malls

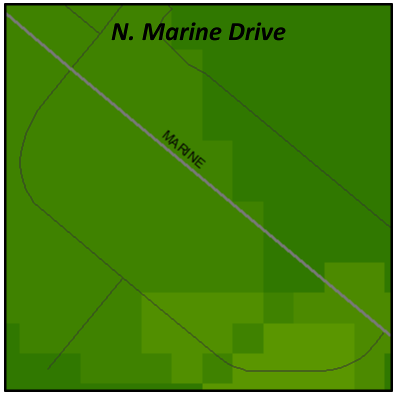


40 – Suburban neighborhoods/subdivisions

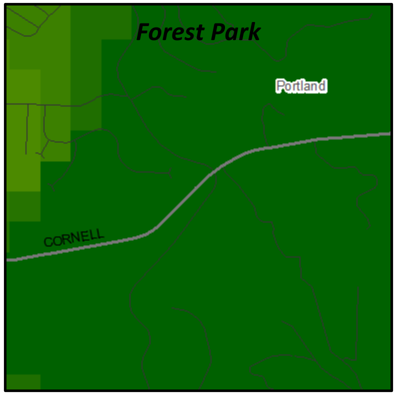


Visualizing PIE

30 – Isolated business and light industry



20 – Rural, undeveloped, forested



I. TRIP GENERATION

I Trip Generation

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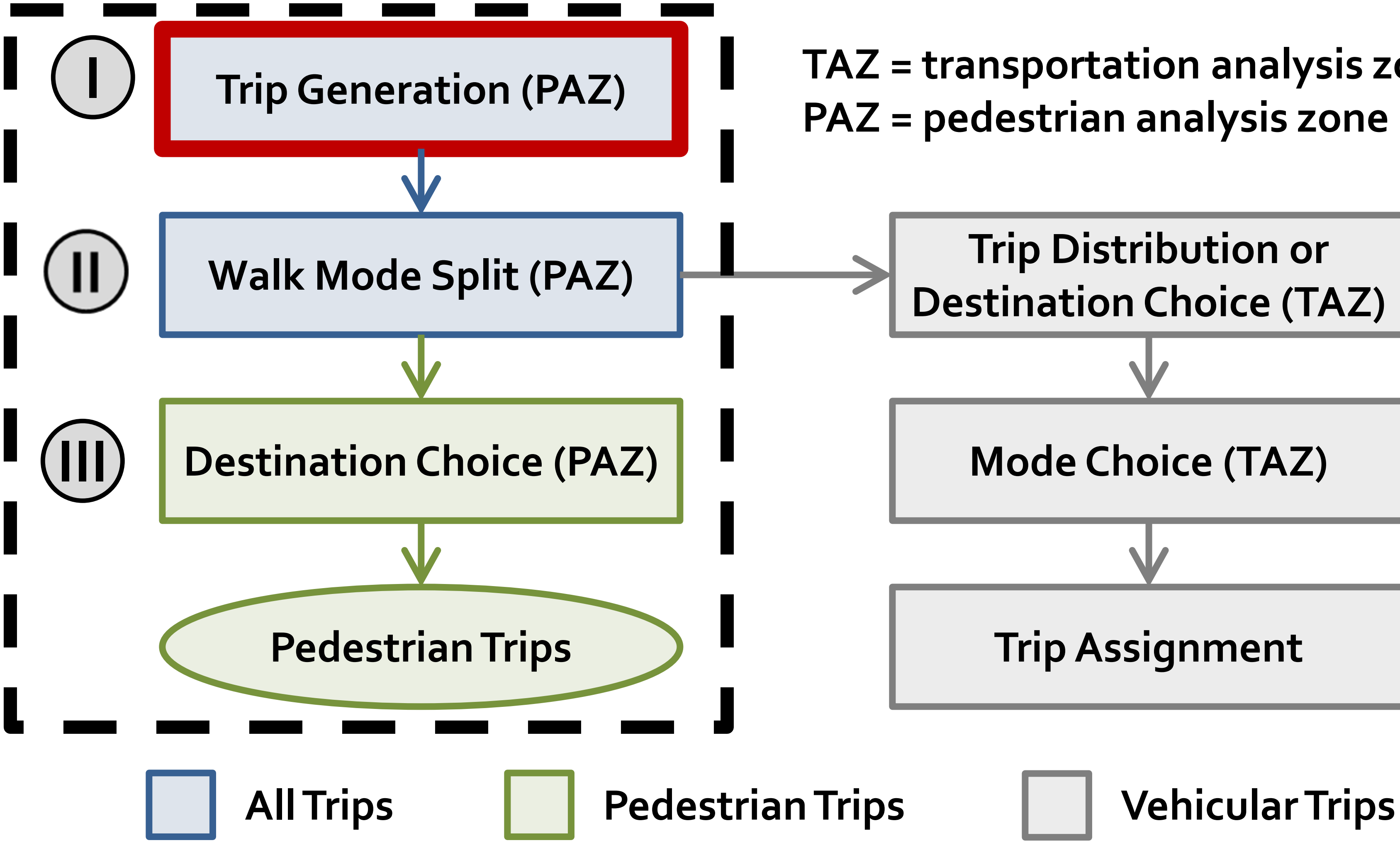
TAZ = transportation analysis zone
PAZ = pedestrian analysis zone



Ⓘ Trip Generation

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Metro currently has 8 trip production models applied to ~2,000 TAZs:

- HBW – Home-based work;
- HBshop – Home-based shopping;
- HBrec – Home-based recreation;
- HBoth – Home-based other (excludes school and college);
- NHBW – Non-home-based work;
- NHBNW – Non-home-based non-work;
- HBcoll – Home-based college; and
- HBsch – Home-based school.

After testing for scalability, we applied <u>the same models</u> to our pedestrian scale ~1.5M PAZs

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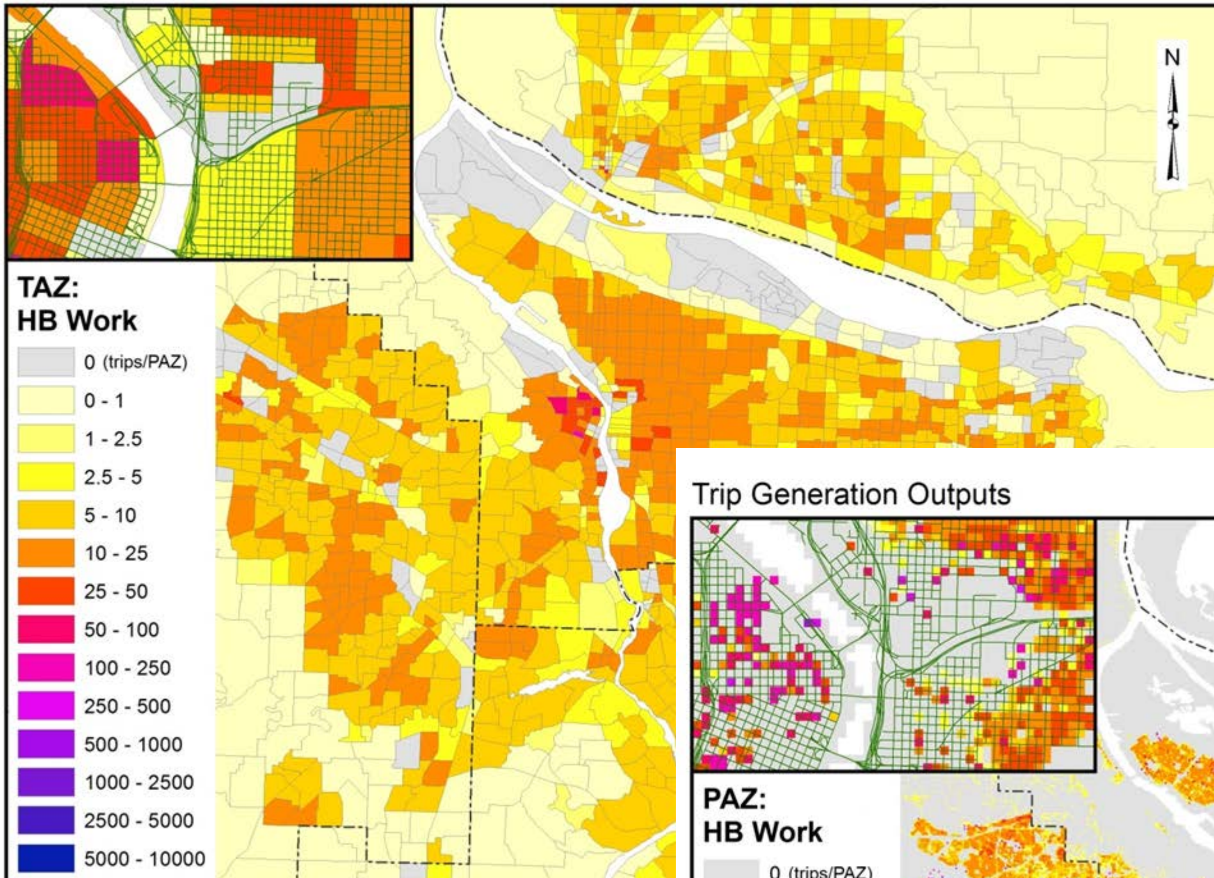
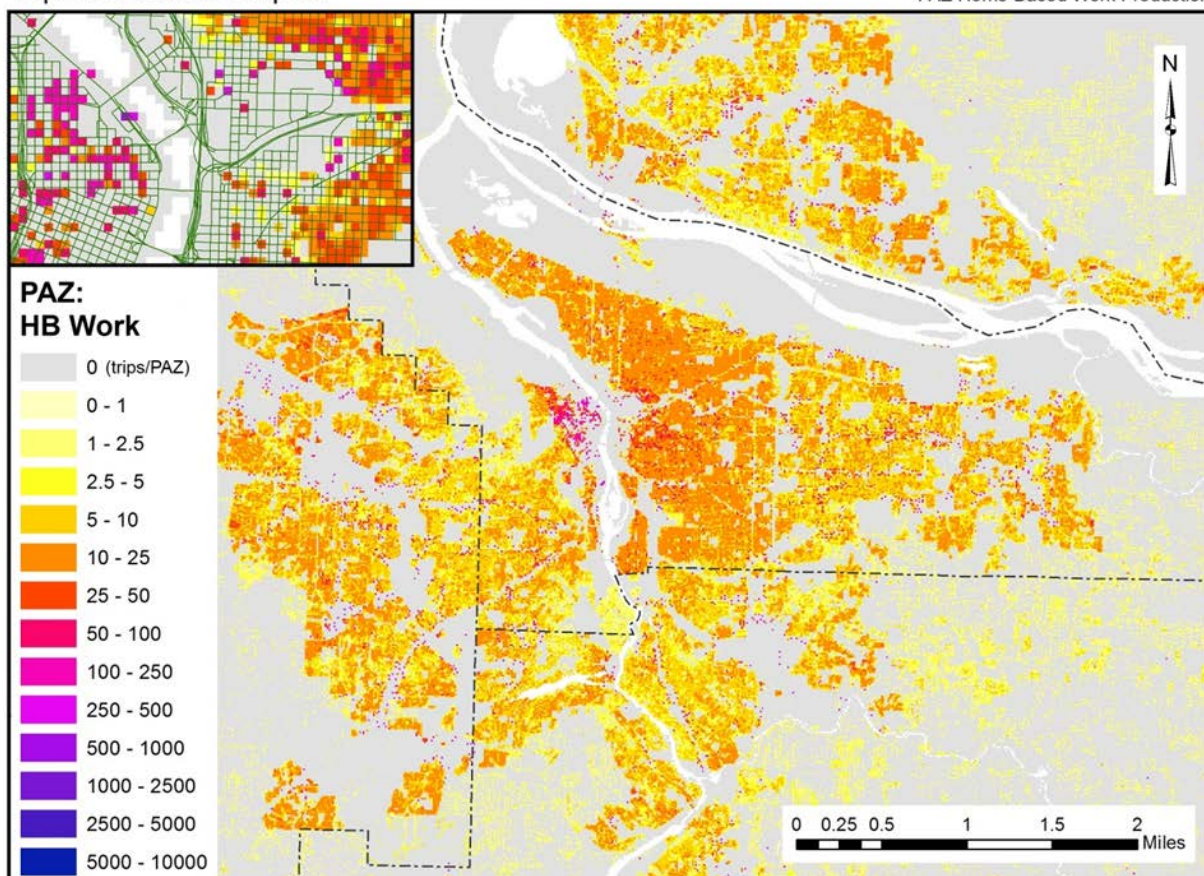
Trip Generation Outputs

TAZ Home-Based Work Productions



Trip Generation Outputs

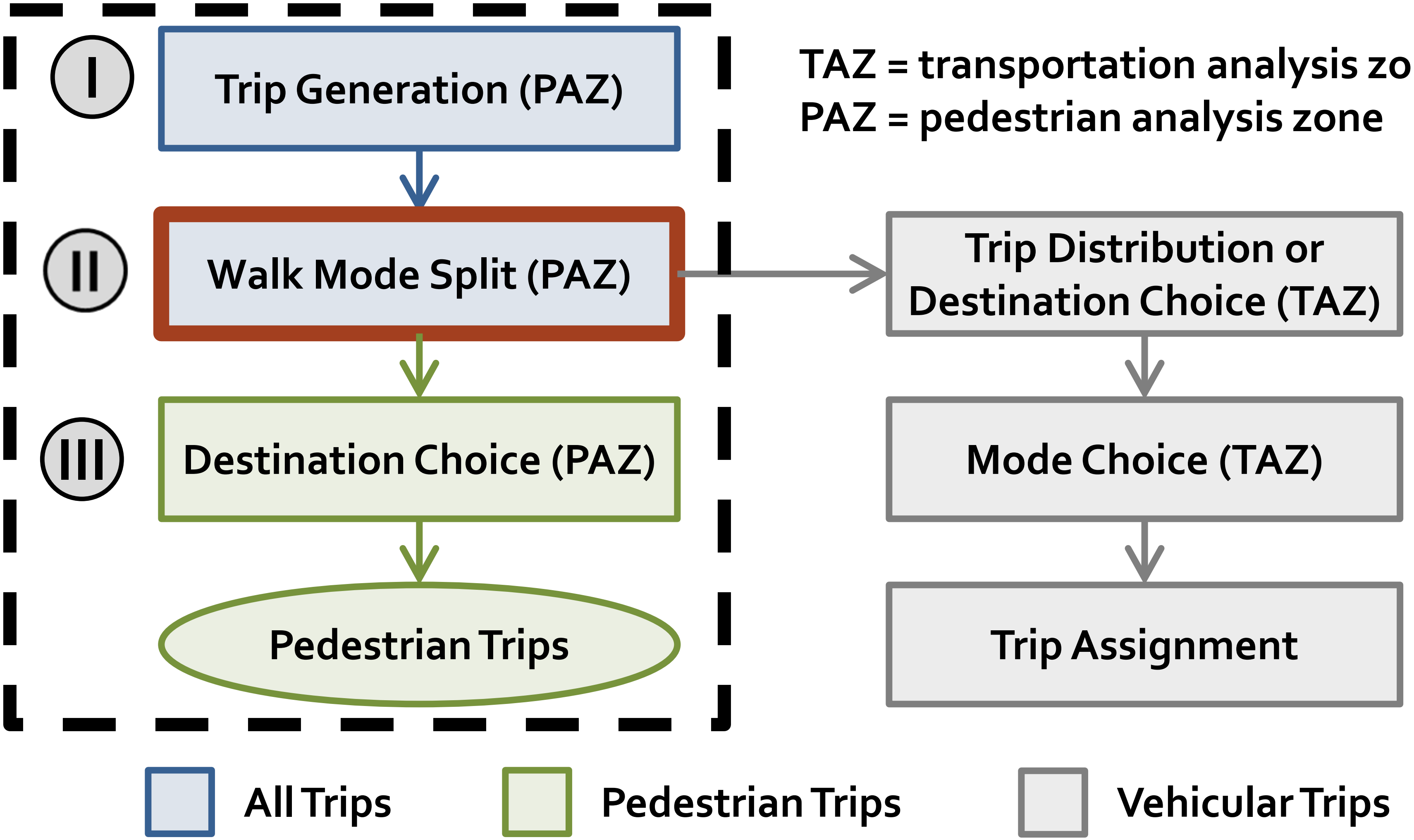
PAZ Home-Based Work Productions



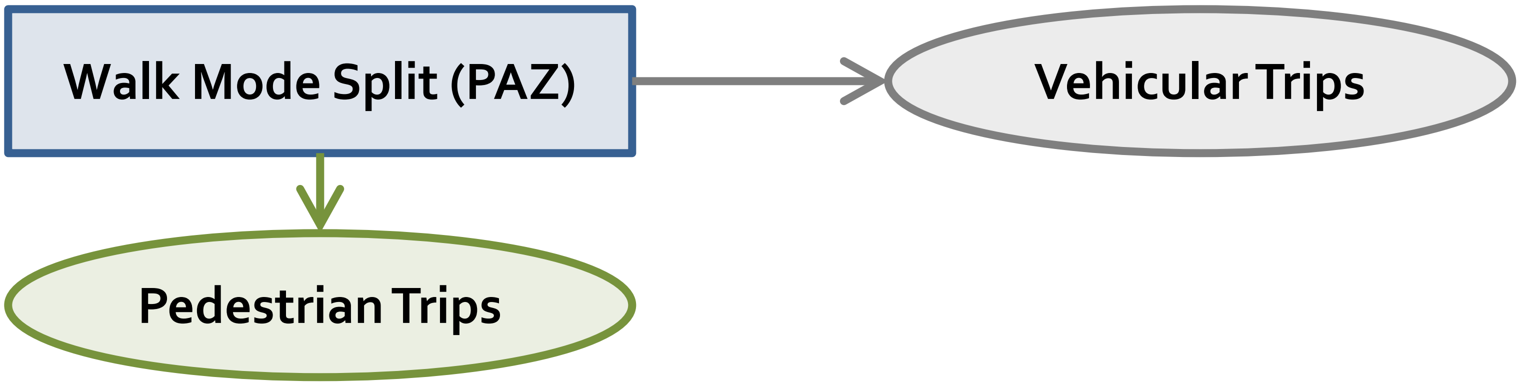
II. WALK MODE SPLIT

II Walk mode split

TAZ = transportation analysis zone
PAZ = pedestrian analysis zone



Ⅱ Walk mode split



Prob(walk) = ***f(traveler characteristics, PIE)***

Data: 2011 OHAS, Production trip ends, 90% sample

Method: binary logit model

Spatial unit: pedestrian analysis zone (PAZ)

II Walk mode split models

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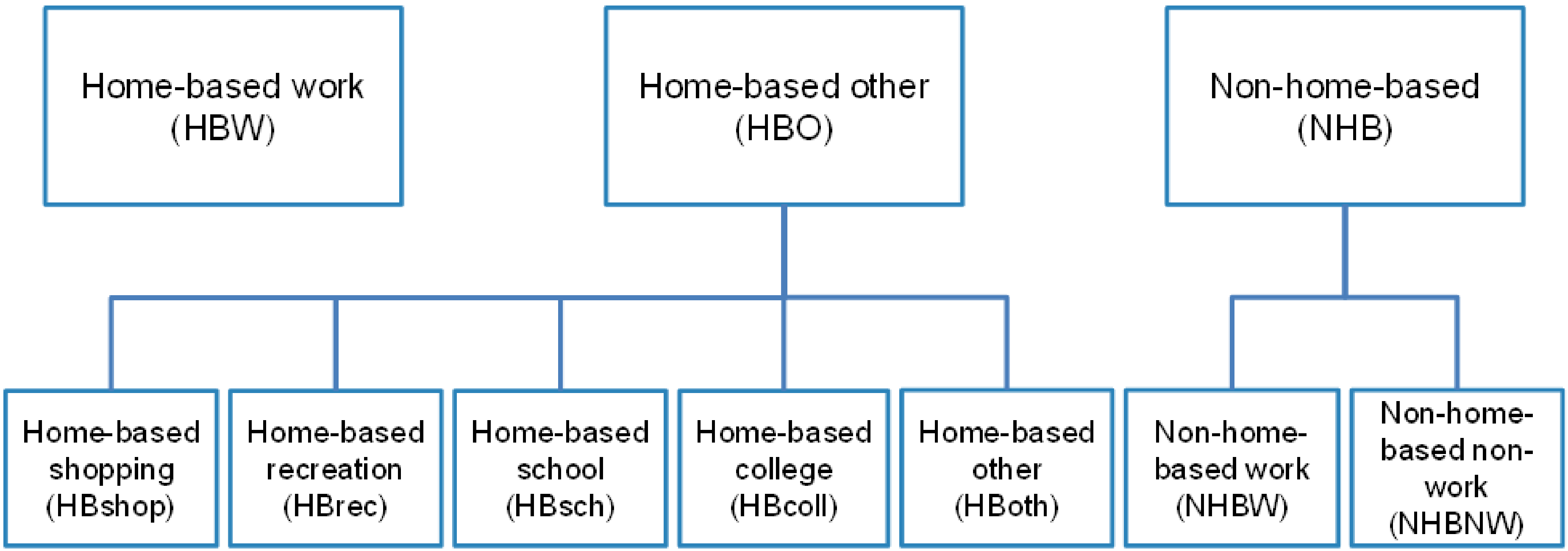


Traveler characteristics:	Household size, income, age, # of workers, # children, # vehicles
Built environment:	PIE

II Walk model results

Traveler characteristics:

+ positively related to walking	*– negatively related to walking*
number of children in HH	age of household head
	HH vehicle ownership

Ped. Environment:

	Δ odds of choosing to walk
+ 10 points PIE	43% increase (HBW)
	54% increase (HBNW)
	67% increase (NHB)

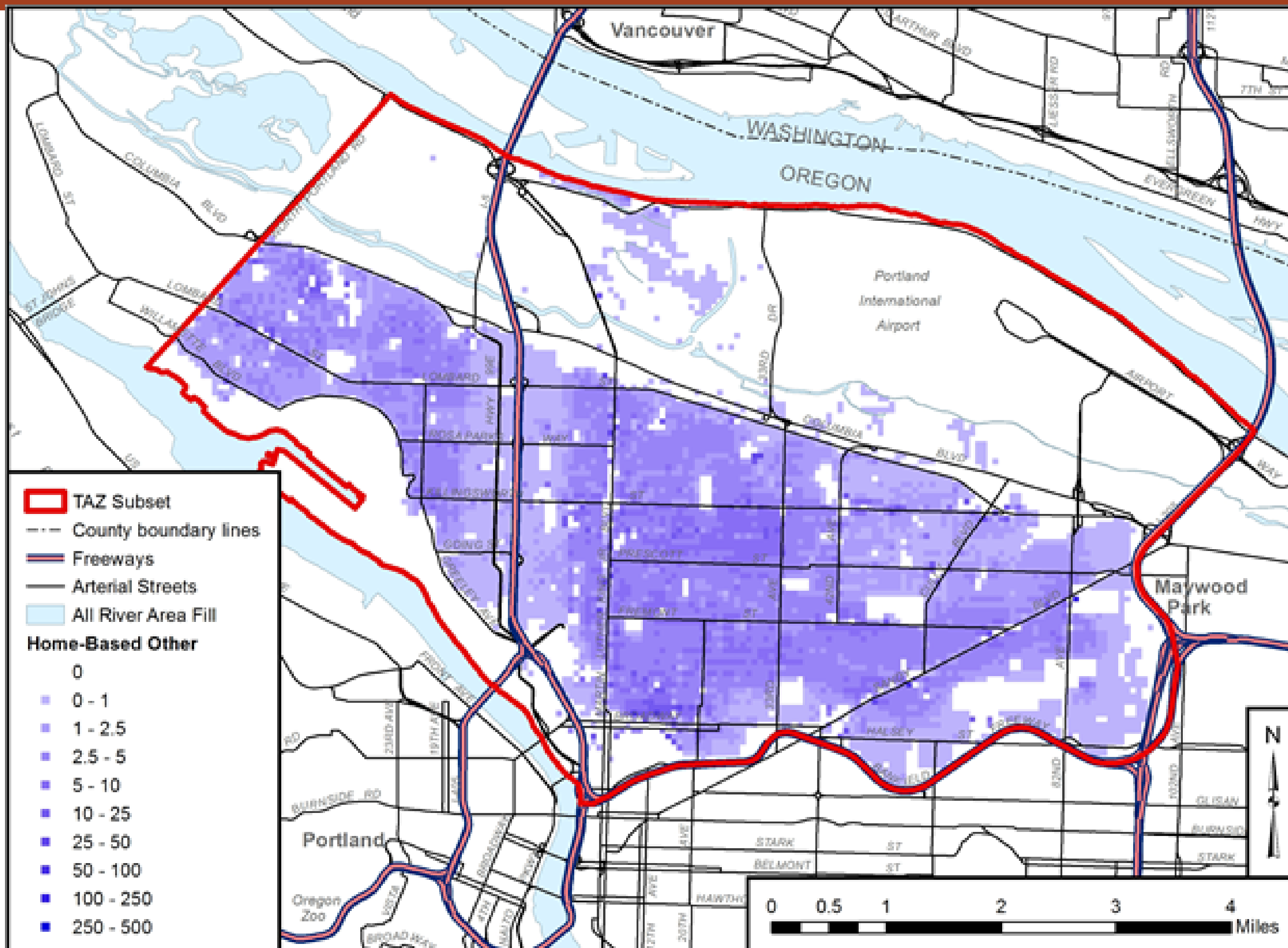
Pseudo R^2 0.137 (HBNW) – 0.253 (NHB)

Mode Split Validation

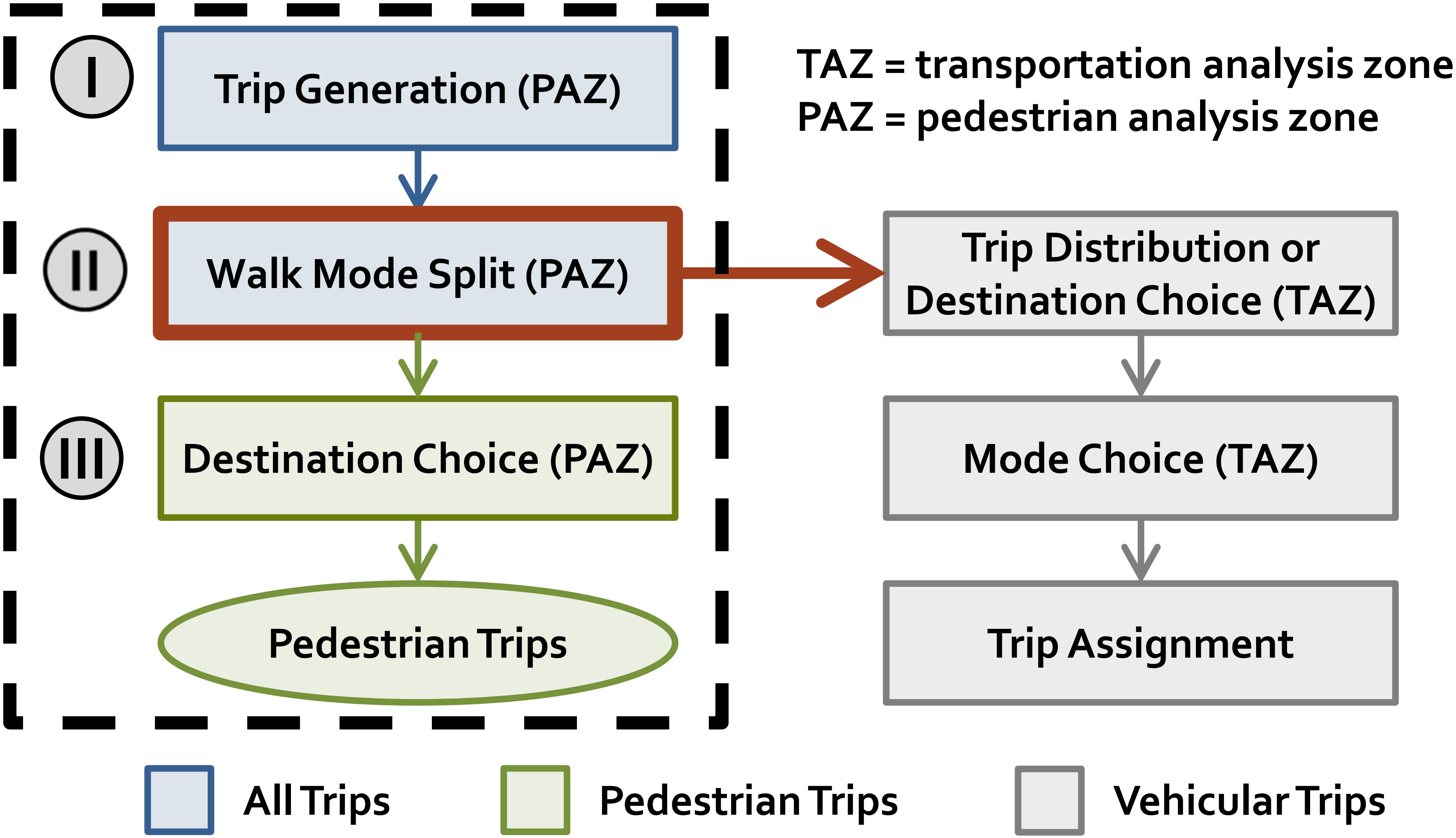
1. Apply the final model equations to trips in the validation sample (10% of data) and calculate the walk probability for each trip;
2. Average the probabilities to get the predicted walk mode share of trip ends (called sample enumeration)

	Model		
	HBW	HBO	NHB
Observed Walk Mode Share	2.9%	9.4%	6.7%
Predicted Walk Mode Share	3.0%	9.5%	8.6%

Ⅱ Walk model application



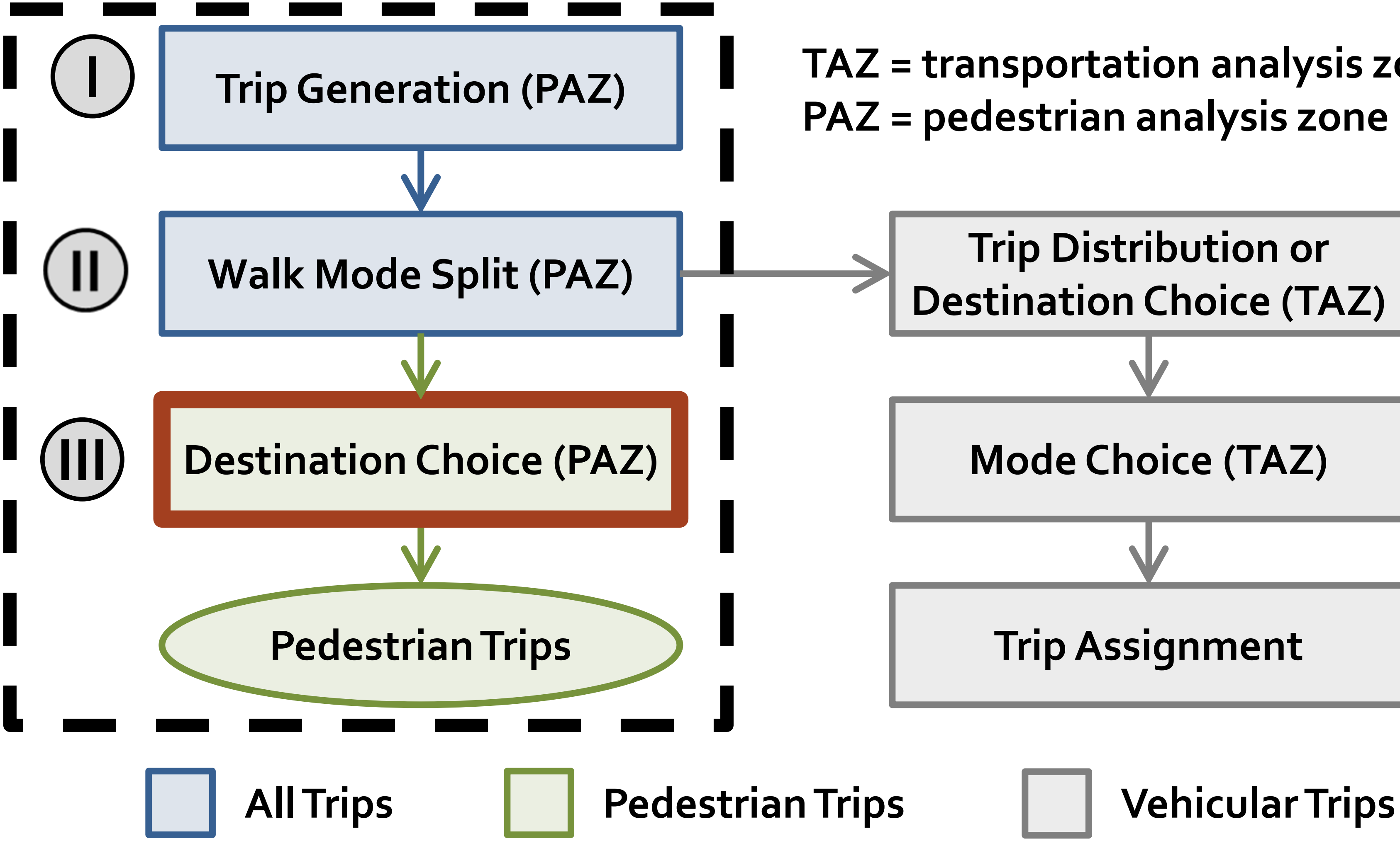
Ⓘⓘ Walk mode split



III. DESTINATION CHOICE

III Destination choice

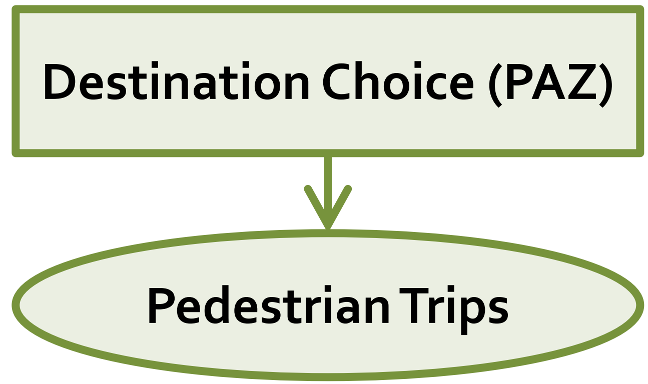
TAZ = transportation analysis zone
PAZ = pedestrian analysis zone



III Destination choice

Prob(dest.) = *function of*…

- network distance
- size / # of destinations
- pedestrian environment
- traveler characteristics



Data: 2011 OHAS

Method: multinomial logit model

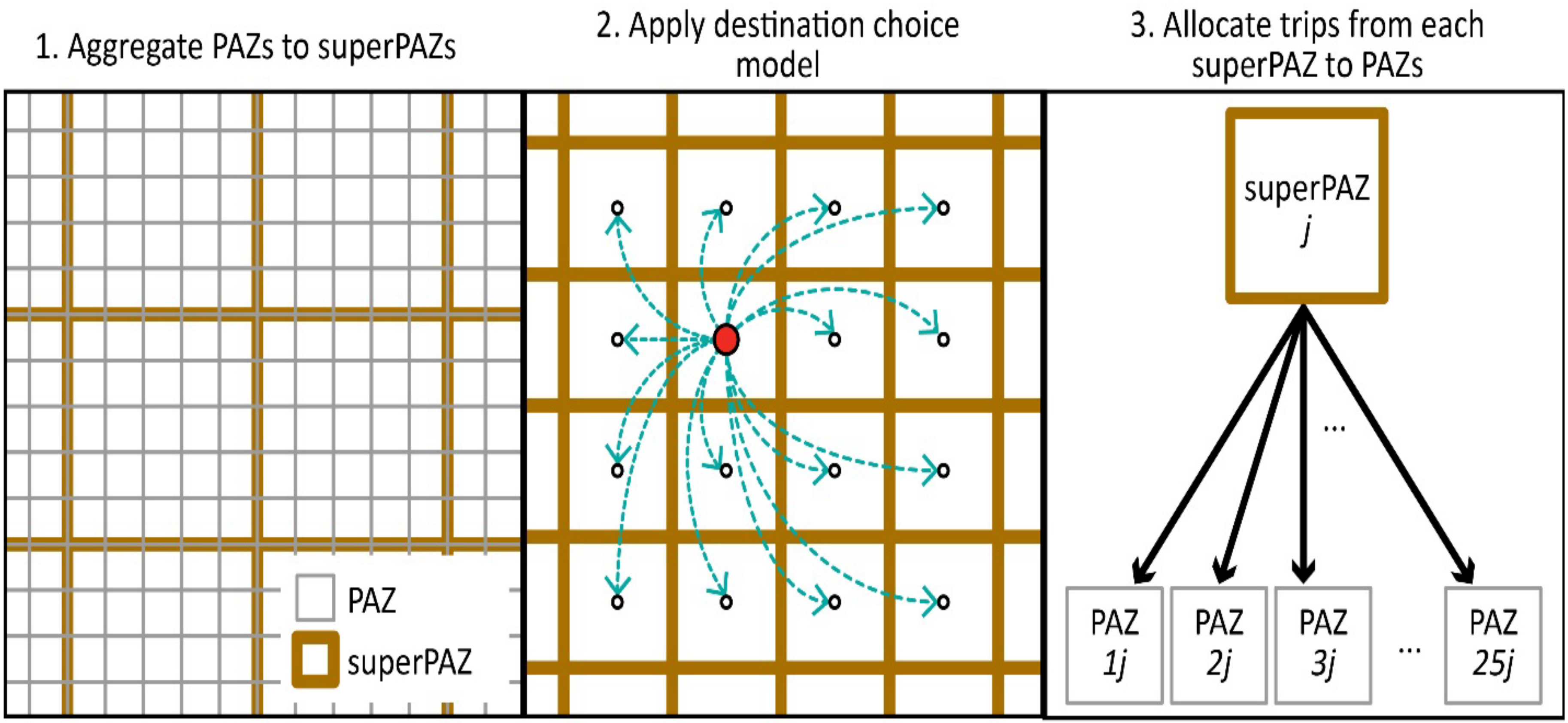
Spatial unit: super-pedestrian analysis zone

Six trip types:

home-based: work (HBW), shopping (HBS), recreation (HBR), & other (HBO);

non-home-based: work (NHBW) and non-work (NHBNW)

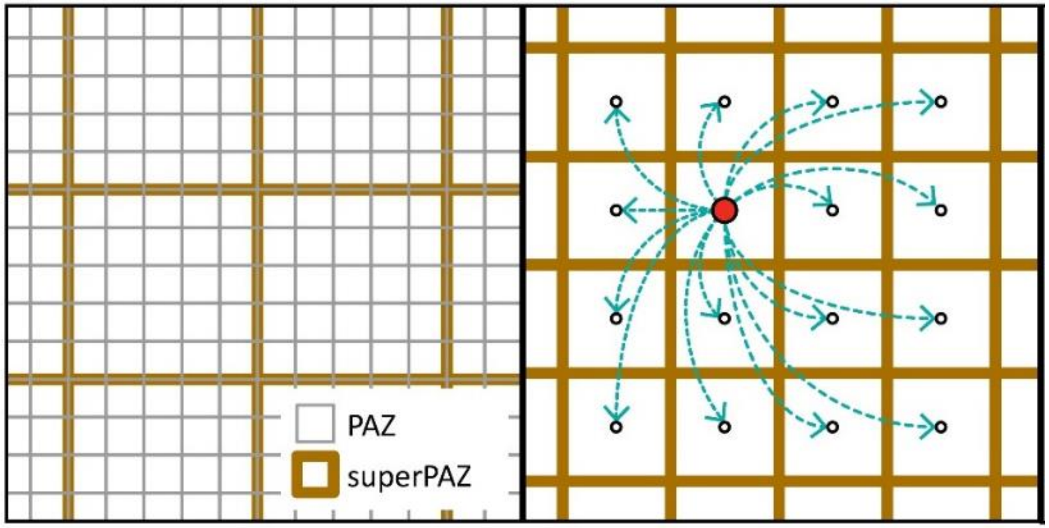
Destination choice



III Destination Choice

superPAZ:

- a grid of
  5 × 5 = 25 PAZs



Choice set generation:

- Random sample of 10 superPAZs within 3 miles
- 99% of OHAS walk trips < 3 miles (4.8 km)

III Destination Choice

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Key variables

Impedance

network distance btw. zones

Size

employment by category, households

Additional variables

Pedestrian supports

PIE, parks

Pedestrian barriers

slope, freeway, industrial LUs

Traveler attributes

auto own., children

III Destination Choice

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Impedance	***Δ odds of walking to destination***
+ 1 mile of distance	76–86% decrease (*)
by auto own.:	-62% (no), -74% (yes) (HBW)
by children:	-78% (no), -83% (yes) (HBR)
by children:	-78% (no), -90% (yes) (HBS)

* Except for HBW, HBR, and HBS.

Size	***Δ odds of walking to destination***
2 × # destinations	28–42% increase (†)
minimum:	4% increase (HBR)
maximum:	88% increase (HBS)

† Except for HBR and HBS.

III

Destination Choice

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Ped. supports	***Δ odds of walking to destination***
+ 10 points PIE:	16–34% increase (*)
presence of park:	58% increase (HBR)

* Except for HBS and HBR.

Ped. Barriers	***Δ odds of walking to destination***
+ 1° mean slope:	14–35% decrease (2,3,4)
presence of freeway:	64% decrease (2)
+ 1% industrial jobs:	33–82% decrease (1,2,3,4)

[1] HBW, [2] HBS, [3] HBO, [4] NHBW.

Pseudo R^2 **0.416 (HBR) – 0.680 (HBS)**

III Destination Choice

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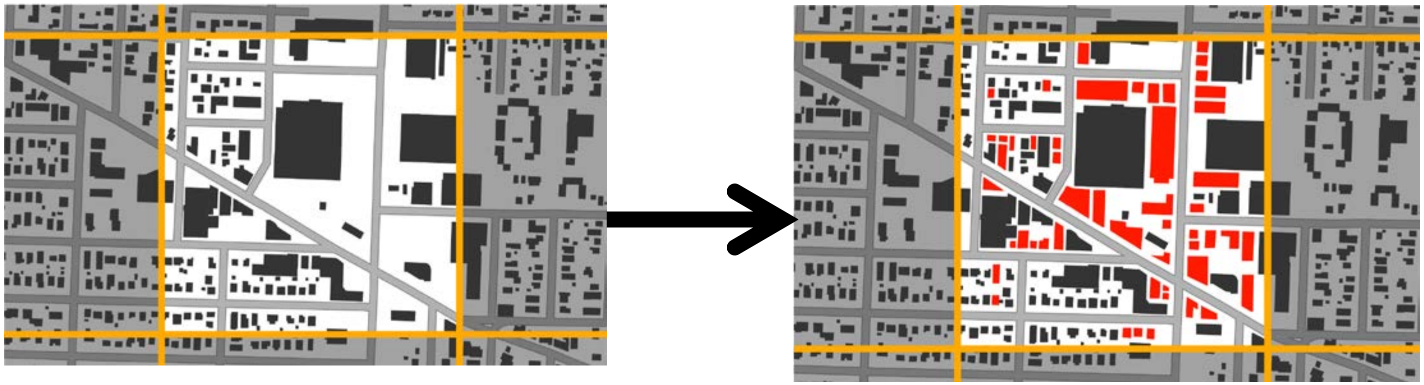
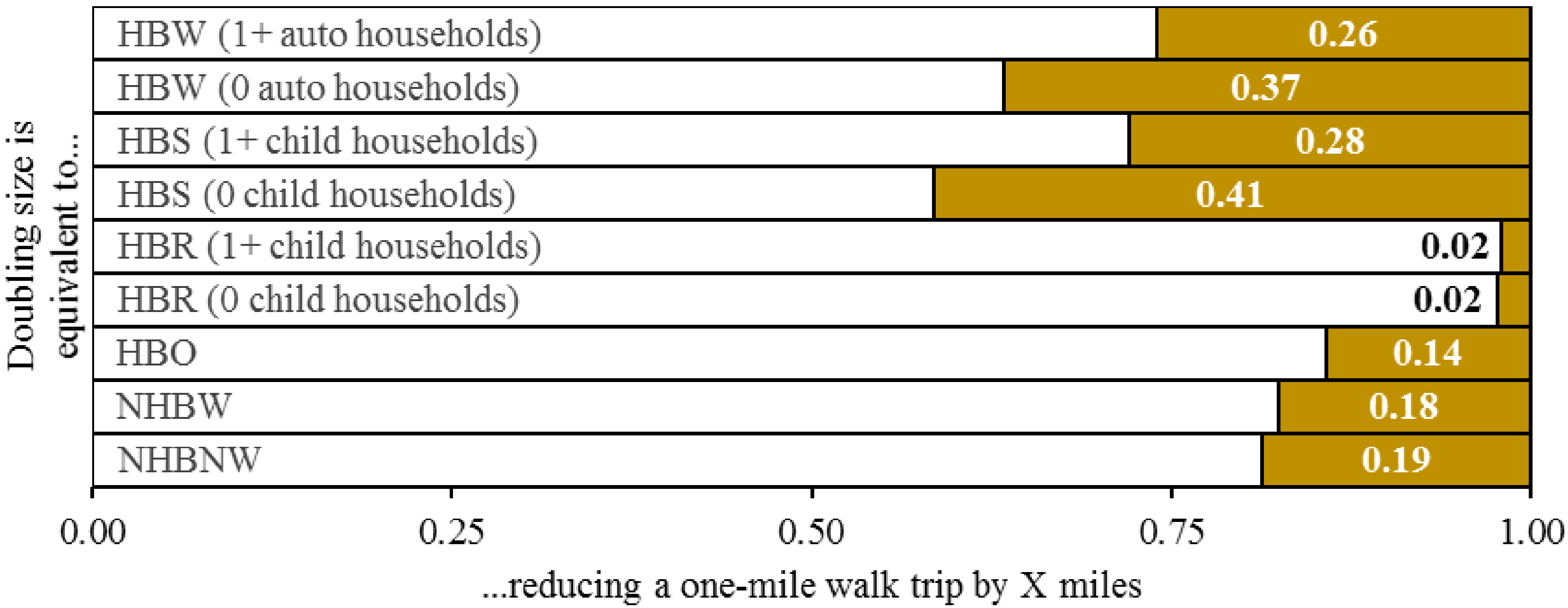
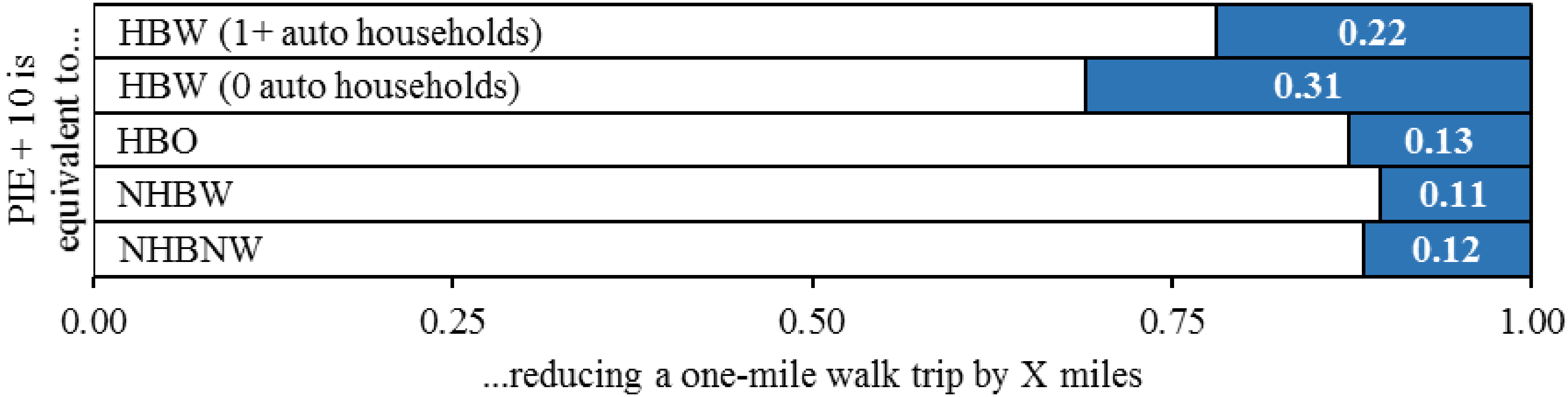


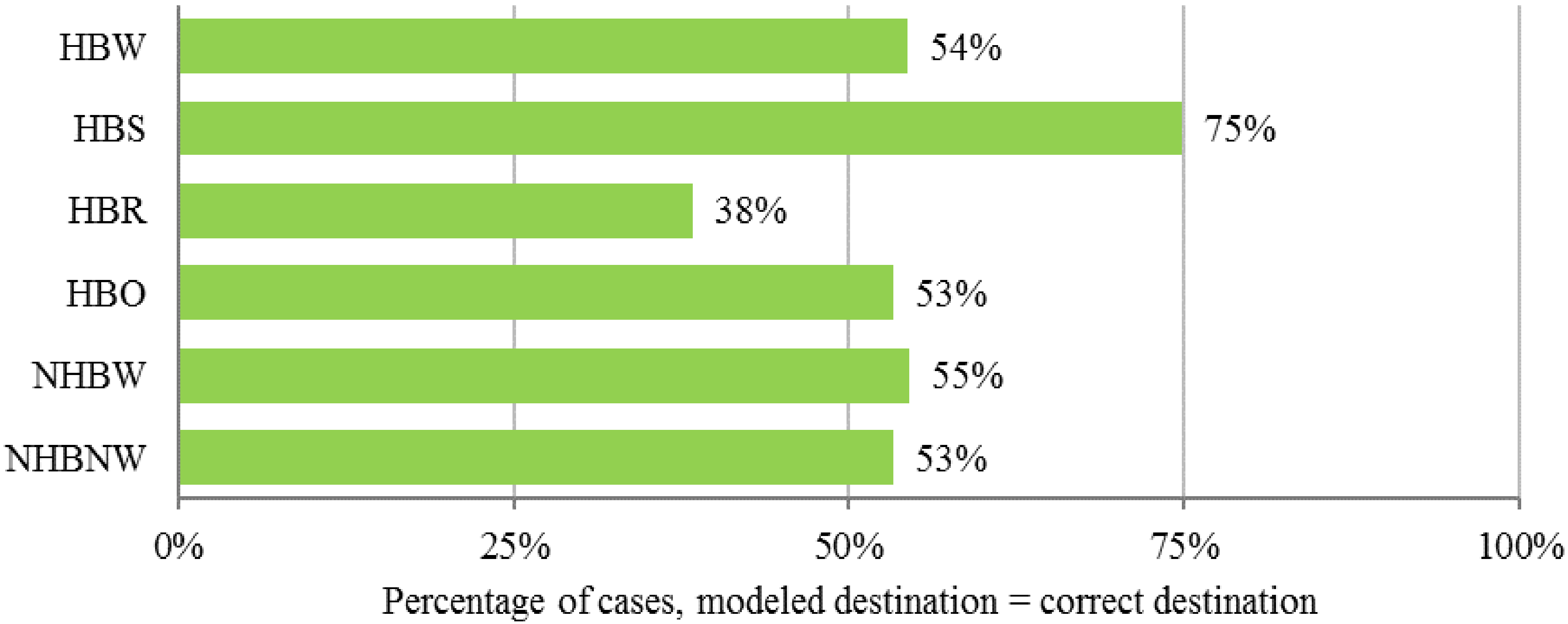


Destination Choice



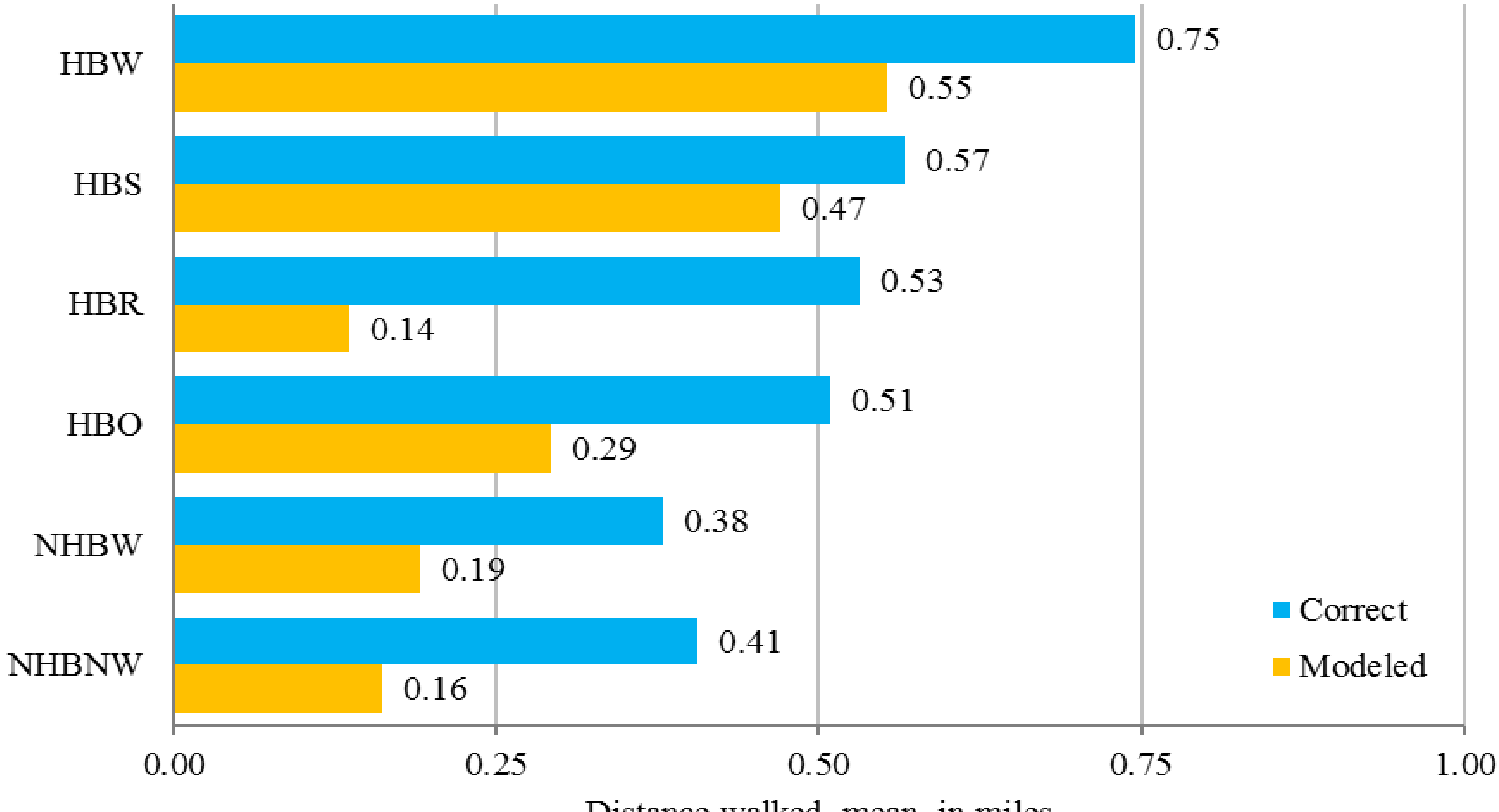
Destination choice

Model Validation – % Correct Destination

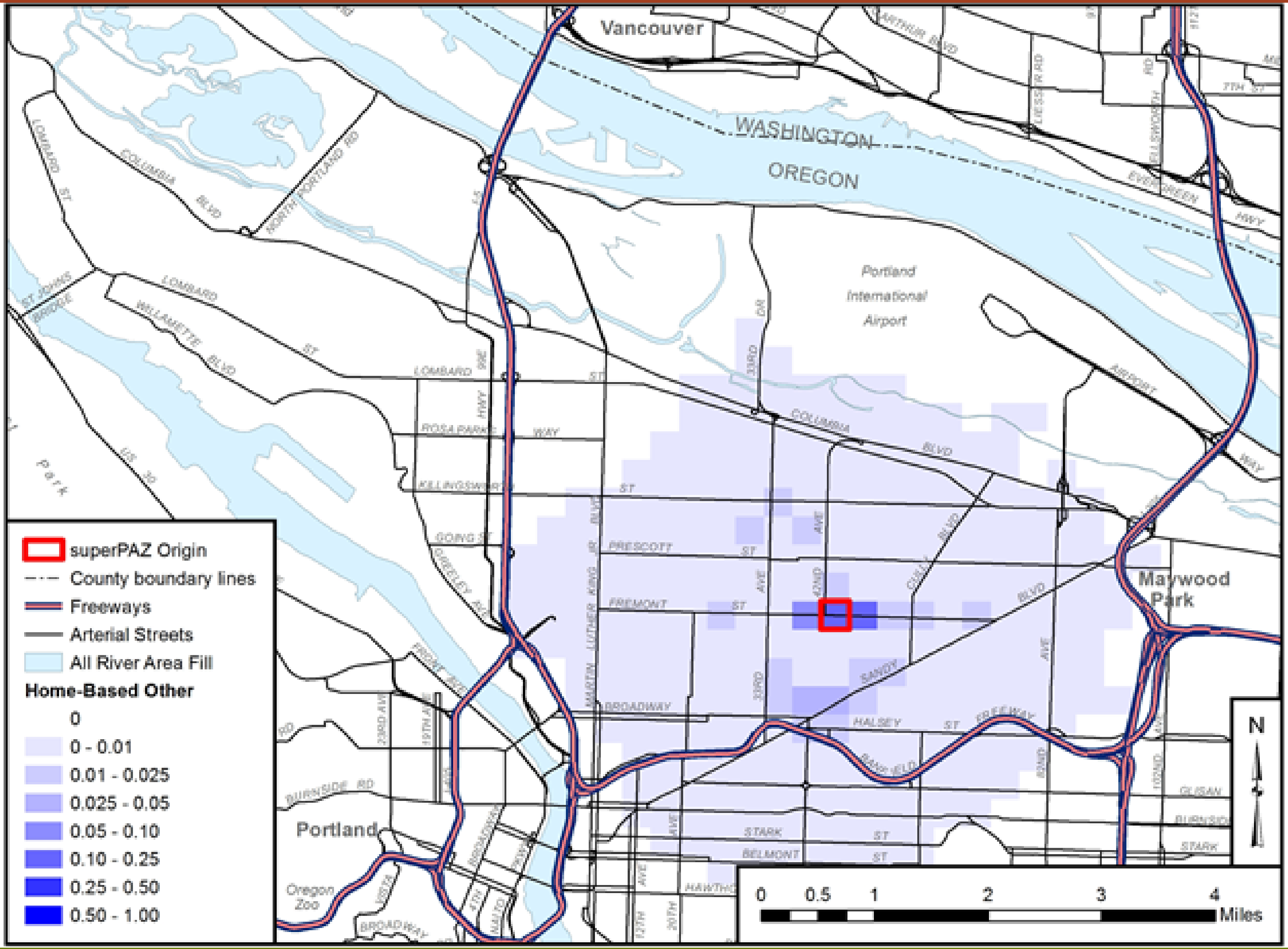


Destination Choice

Model Validation – Avg. Distance Walked



Destination Choice



CONCLUSIONS & FUTURE WORK

Conclusions

- Nests within current model but can be used alone
- Pedestrian scale analysis (PAZs)
- Pedestrian-relevant variables (PIE)
- One of the first studies to examine pedestrian destination choice in modeling framework
- Highlights policy relevant variables: distance, size, pedestrian supports & barriers

Future work

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Before application:

- Relate PIE more explicitly to policy changes
- Forecasting inputs
- Test method in other area(s)/regions
  - Examine relationships in other contexts
  - Assess PIE's transferability
- Provide agency guidance for implementation

Future work

Research & Model Improvements:

Trip Generation
- Multinomial Logit model

- **Destination Choice**
  - Allocate from superPAZ to PAZ level
  - Explore non-linear effects & other interactions
- **Route choices or potential pathways**
  - Need fundamental research to improve understanding

Questions?

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Project info & reports:

http://trec.pdx.edu/research/project/510
http://trec.pdx.edu/research/project/677

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Kelly J. Clifton, PhD — kclifton@pdx.edu

Patrick A. Singleton — Portland State University

Christopher Muhs — DKS & Associates

Robert Schneider, PhD — Univ. Wisconsin–Milwaukee